



Advanced Concepts and Systems Analysis

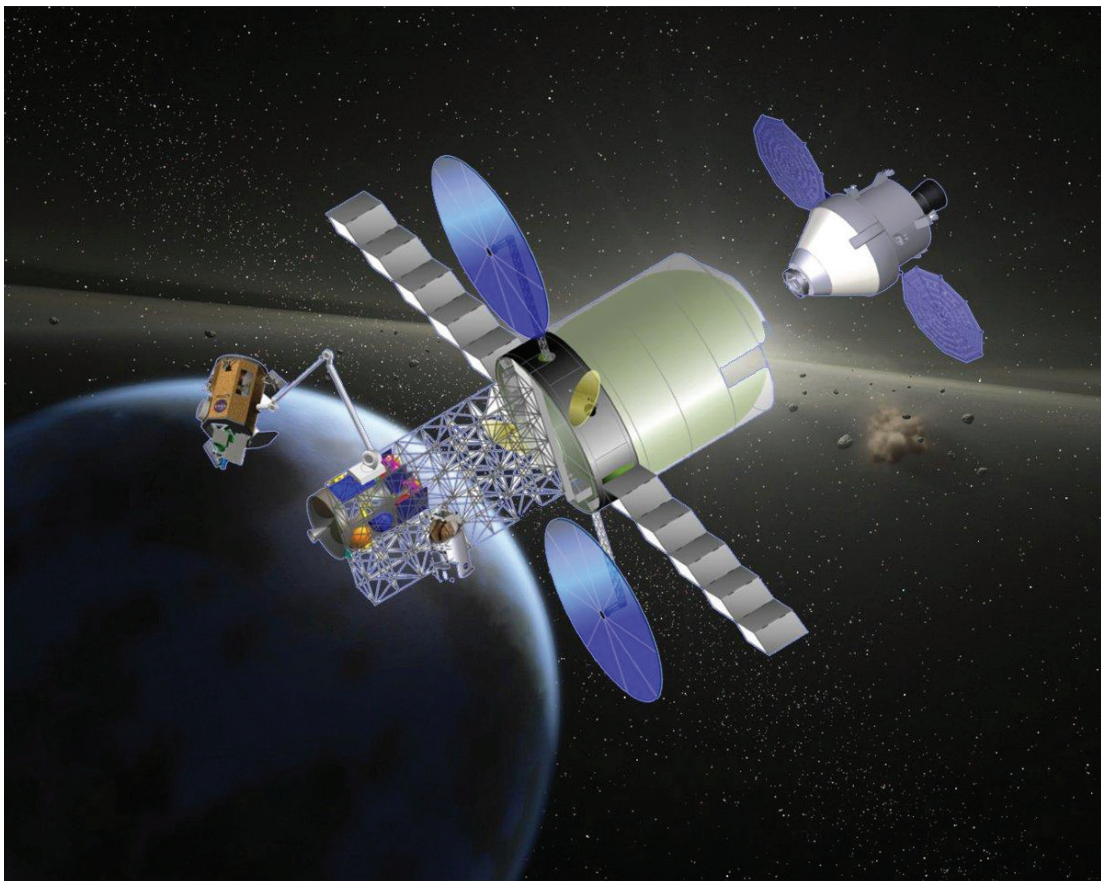
Rapid Architecture Solutions

Advanced space systems are growing more complex in size and scope, making systems analysis and engineering ever more critical to a successful mission, whether for free-flying satellites or human-rated vehicles. Decisions made early in design reverberate through design, development, operations, safety, and cost. Both programs and principal investigators need expert architecture studies done quickly.

With a collaborative and customer-focused approach, Marshall's Advanced Concepts Office offers expertise in advanced concepts and systems analysis to create a launching point for next-generation space systems. Using a multi-discipline approach, engineers provide rapid development and analysis of innovative solutions to difficult problems. The core team has decades of experience in both launch vehicle and space system concept design and offers physics-based analysis rather than simple database or analog lookup, yielding an end-to-end design capability for preliminary concepts.

At-A-Glance

Providing advanced concepts and powerful multidiscipline systems analysis, Marshall Space Flight Center's Advanced Concepts Office (ACO) specializes in high-fidelity pre-Phase A and Phase A concept definition studies for space exploration systems. For today's competitive environment, the ACO provides a rigorous, expedient, and cost-effective way to achieve every mission's design goals.



Marshall conceived and assessed a Skylab-inspired habitat for deep space exploration using the SLS.

Broad Experience, Deep Expertise

The ACO is unique throughout NASA for its breadth of experience in both space system conceptual analyses and integrated architecture. The office has studied Earth-to-orbit and in-space transportation systems and elements of exploration and discovery missions, including landers, habitats, planetary surface systems, and science systems. Well-known for its work on Earth-to-orbit missions, the ACO performs trajectory analyses, weights and sizing, vehicle structural analyses, and system level trades. The team also has expertise with in-space, exploration, and discovery studies. Work on in-space missions encompasses architecture, operations and mission analysis, technology assessments, in-space element definition, and habitation and crew systems. On exploration and discovery studies, the ACO has provided customers with mission concept definition and spacecraft concept designs for scientific and robotic exploration, human exploration, and technology demonstrations.

By conducting tailored, highly focused one- to four-week studies, Marshall's ACO provides services to customers within NASA, the Department of Defense, universities, and throughout the commercial space flight

industry. The office works alongside its customers to quickly meet project goals within the customer's unique requirements and establish a solid foundation for project and mission success.

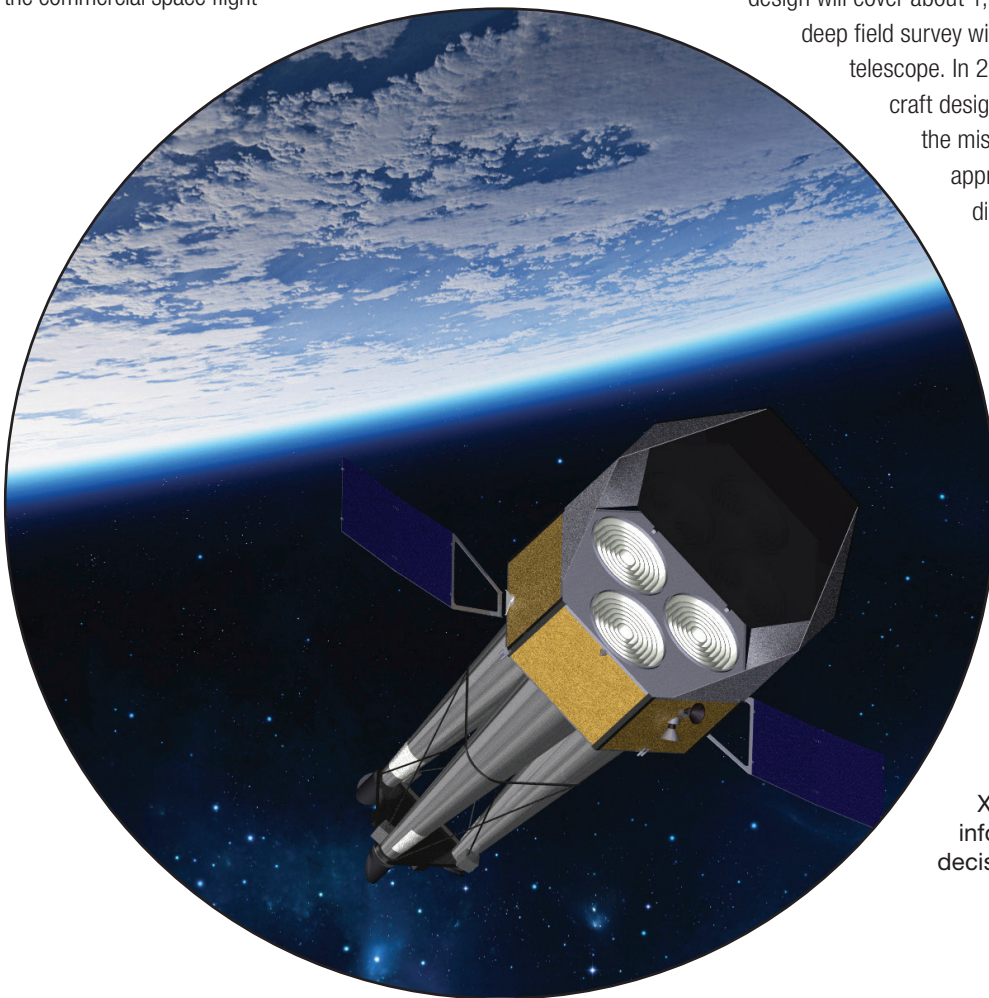
Recent or Current Study Highlights

Marshall and the ACO are best known for their work with Earth-to-orbit vehicles, from small satellite delivery to super heavy lift. Marshall is a pioneer in propulsion, including chemical and cryogenic, nuclear electric interplanetary, solar electric, and solar sails. While propulsion and launch are Marshall's recognized specialties, the ACO has also been critical in the development of other mission areas, including:

- Human health, life support, and habitation systems
- Orbital vehicles from nano-satellites to large vehicles, including the Hubble Space Telescope and Chandra X-ray Observatory
- Planetary surface systems

Marshall is partnering with Johns Hopkins University and other leaders in the science community on a ground-breaking astrophysics mission concept to design the Wide Field X-ray Telescope (WFXT), a proposed successor to Chandra. This telescope's innovative wide-field X-ray optics design will cover about 1,000 times the area of the Chandra telescope

deep field survey with greater sensitivity than any previous X-ray telescope. In 2012, the ACO completed a conceptual spacecraft design of the WFXT to demonstrate the feasibility of the mission. The collaborative multidiscipline design approach called on experts from across spacecraft disciplines, including configuration, avionics, thermal, power, propulsion, guidance and navigation, and structures. Positive results of the study supported Marshall's decision to purchase equipment to reduce the risk of replicated optics for WFXT.



ACO's thirty-day feasibility study of the Wide-Field X-ray Telescope informed key decisions.

Resources for Rapid Delivery of Robust Ideas

The ACO combines the necessary expertise with the latest design and analysis tools to translate ideas into robust engineering designs. Much of the office's modeling and high-fidelity animation for engineering analysis uses industry-standard computer tools, enabling efficient sharing of information with customers and other project teams. To support the specialized nature of many conceptual design studies, the ACO has created a suite of custom tools that enable tasks such as spacecraft performance and subsystem design analysis.

Built on a comprehensive systems-based approach, the ACO's innovative design process consists of three collaborative phases, often executed in parallel to speed design iterations and lead to faster solutions:

- **Architecture Definition** is an iterative process involving analysis tasks to define the mission profile and identify mission options that compose the mission and vehicle trade space.

- **Vehicle Definition**, closely linked to the architecture definition process and based on requirements derived from the mission analysis, forms the basis for vehicle performance and subsystem design assumptions.
- **Systems Engineering** processes are conducted in parallel with the mission and vehicle definition processes and, to the extent possible, for pre-phase A and conceptual design studies.

The ACO offers customers a state-of-the-art collaboration space, the Advanced Concepts Design Center (ACDC), to support the development and analysis of new mission and space vehicle concepts. ACDC gives mission teams significant opportunities to gain efficiency and improve processes during the concept design phase and supports project teams of up to 25 people. The room facilitates creative thinking and streamlined access to strategic models and operational information. A flexible layout allows the ACDC to be quickly reconfigured to accommodate changing needs of the study team.



In the ACDC collaborative environment, teams quickly develop and assess design concepts.

Beyond Earth Orbit: SLS Utilization Mission Opportunities

NASA is developing technology now to prepare for large space missions far beyond Earth orbit. With the Space Launch System (SLS), NASA and its partners will explore asteroids, the moon, Mars — and beyond. The SLS is designed to be flexible and evolvable and to meet diverse mission needs such as retrieving samples from the outer planets, launching deep space habitats, and enabling human exploration of Mars.

Leveraging the extensive experience of Marshall engineers in both launch vehicle and space system concept development, the ACO identified more than 40 missions that SLS would enhance — including Earth orbit, lunar, planetary, near Earth asteroid, and comet — many rooted in decadal surveys conducted by the National Research Council. From these studies, the ACO identified four major benefits overall to the utilization of the SLS: reduced trip time, reduced complexity, increased payload, and increased reliability.

Skylab II (SLS-derived Deep Space Habitat)

Skylab II is a concept that uses an empty SLS propellant tank for a deep space habitat. Similar to the original Skylab (operated 1973-74), it is a low-cost, low-risk solution benefiting from the SLS large diameter and heavy-lift capability for a single launch delivery. It provides ample volume for the crew and operations. Commonality with the SLS ensures launch vehicle compatibility with minimized development time.

Jupiter Europa Orbiter Mission

The ACO's studies reveal that with an SLS launch capability, exploration of Jupiter's moon Europa can be completed faster and return more data than with existing launch vehicles. The SLS could send this spacecraft directly to Jupiter, reducing the need for gravity-assist trajectories that increase transit time and mission risk.

ACO continues to evaluate the many scientific and exploration missions enabled by the heavy-lift capability of the SLS.

Mars Sample Return Mission

A Mars Sample Return mission under consideration consists of three spacecraft. The ACO determined that the SLS can provide a single-launch Mars Sample Return solution, in contrast to the baseline three-launch architecture, greatly reducing mission risk and increasing sample return mass by a factor of 10.



National Aeronautics and Space Administration

George C. Marshall Space Flight Center

Huntsville, AL 35812

www.nasa.gov/marshall

www.nasa.gov



Learn more about how you can access these capabilities and more provided by Marshall Space Flight Center:

www.nasa.gov/marshallcapabilities

*Launching the Future of
Science and Exploration*